Scottish Home and Health Department
Scottish Health Service Planning Council

Diagnostic Radiology in Scotland in the 1980s

A report by a Working Party of the Radiology Sub-Committee of the National Medical Consultative Committee

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First published 1983

ISBN 0 11 492297 7

Note by Scottish Home and Health Department

This Report has been prepared by a Working Party of the Radiology Sub-Committee of the National Medical Consultative Committee and has been endorsed by the Scottish Health Service Planning Council. Following a recommendation of the Planning Council it is now being published for the information of Health Boards and other bodies and individuals with an interest in radiology.

The Report, its conclusions and recommendations should not be taken as necessarily reflecting the policy of the Scottish Home and Health Department.

Preface

This Report has been prepared by a Working Party (see page 7) of the Radiology Sub-Committee of the National Medical Consultative Committee (see Appendix A). The remit of the Working Party was to 'provide information on the present state of diagnostic radiology in Scotland and its likely future during this decade, with particular reference to the use and value of new techniques, the economic use of resources and the workload of staff'.

The Report indicates that the techniques of ultrasound, computed tomography and radio-isotopes form an increasing proportion of the imaging work of radiology departments; and it predicts that the emergence of newer forms of imaging is likely to modify further the work pattern. It shows that these new techniques are supplementing and supplanting certain conventional radiological procedures and may be performed conveniently on an out-patient basis.

The Report concludes that integration of these new modalities is essential if they are to be used efficiently, and it emphasises that full cooperation of the clinical users is a vital factor in the economic operation of a modern imaging service.

A chapter on the internal workings of the radiological imaging department illustrates the inter-dependence of the various elements and draws attention to the many factors required to enable professional staff to maximise the application of their diagnostic skills.

It is hoped that this exposition of radiology in the eighties will be of interest and value to those in the clinical and administrative fields who may not be conversant with the widening commitments of modern radiology departments.

I am most grateful to the members of the Working Party for their enthusiastic and constructive approach to the production of this Report.

I wish also to thank the following who provided additional expert advice: Drs. A. F. Macdonald, E Barnett and E. Sweet, Consultant Radiologists; Drs. M. V. Merrick and F. W. Smith, Consultants in Nuclear Medicine; Mr. J. W. Abbot, Group Superintendent Radiographer and Mr. D. T. Graham, Teacher Principal; Mr. Peter Farmer and Mr. Graham Mitchell of the Information Services Division of the CSA; and finally Dr L F Howitt of the Scottish Home and Health Department and Dr D W A McCreadie, formerly of the Scottish Home and Health Department and now with the Building Division of the CSA.

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1 Introduction

1.1 The object of this report is to outline the ways in which the radiological service in Scotland is developing in the 1980s and to offer advice regarding its efficient and economic organisation. The report is opportune because of the dramatic changes which are taking place in the work pattern of departments of diagnostic radiology.

1.2 Since the introduction of the NHS in 1948, there has been an enormous expansion of the radiological service in Scotland. Basic radiological facilities are now available in all parts of the country, more sophisticated services being concentrated in the main centres. Patients obtain their examinations by way of the hospital service, directly through general practitioners or, in some instances, by self-referral.

1.3 The frequency of radiological examinations in Scotland has been estimated at 440 per thousand of the population per annum—this rate being less than countries such as Sweden and the USA, and approximately one third that of the Netherlands and Switzerland.

1.4 In recent years a number of revolutionary imaging methods have been introduced into clinical practice, viz, ultrasound, radioisotope scanning and computed tomography. The impact of these new techniques has been dramatic and their clinical effectiveness has resulted in legitimately heavy demands for their wide availability. Two important effects have resulted: (a) a significant shift in the work pattern of large departments of radiology and (b) a relative and actual increase in time commitment, on the part of radiologists and radiographers, to new forms of imaging.

1.5 On the one hand, these sophisticated developments increase the average cost of imaging techniques. On the other hand, certain economies, which include savings in bed occupancy, can be achieved by using these new imaging methods. More rapid and precise diagnosis speeds up definitive treatment and may, on occasion, obviate exploratory laparotomy; patient morbidity is reduced on account of the non-invasive nature of the tests and the reduced need for procedures requiring general anaesthesia; and a reduction in the overall dose of ionising radiation to the general public can be achieved by an increasing substitution of ultrasound for conventional radiology where appropriate. Economic use of these facilities depends on their proper co-ordination and control.

1.6 An important part of this study was to obtain data on all forms of radiological imaging currently provided and on the numbers of staff engaged in this work. Although many of the new techniques are now firmly established, the influence of these on conventional radiology, and on the organisation, management and costs of the radiology service, has yet to be determined.

1.7 The report which follows explains the scope of modern radiology and provides some indication of future demands. Recommendations are made concerning the proper use of this increasingly complex service. It is considered that such information will be helpful to the staff of radiology departments, to clinicians and, not least, to employing authorities as the ultimate providers of medical services.

1.8 All publications referred to in the Report are listed on pages 61 and 62.

2 The Changing Work Pattern in Diagnostic Radiology

2.1 Radiology departments in Scotland range from complex suites in teaching and district general hospitals to single handed departments in cottage hospitals and health centres equipped with basic radiographic apparatus. All have a commitment to a routine diagnostic workload of the established type.

2.2 The introduction of the new imaging techniques of ultrasound, radioisotope scanning and computed tomography is exerting a dramatic influence on the work pattern of departments of diagnostic radiology. Despite the upsurge in workload, these modalities have been received with enthusiasm on account of their diagnostic effectiveness.

2.3 With few exceptions, apparatus for general ultrasound is located in departments of diagnostic radiology. A wide-ranging clinical service (including echocardiography in some instances) is provided by radiologists. Obstetric ultrasound is shared between obstetricians and radiologists, with radiographers playing an increasing role in this field.

2.4 Medical involvement in radioisotope scanning is divided fairly evenly between consultants in nuclear medicine and radiologists working in close association with medical physicists, who have played a leading role in the development of radioisotope scanning services in Scotland.

2.5 The original computed tomographic (CT) machines were dedicated head scanners and these are under the control of neuroradiologists in the four teaching centres. CT body scanning has been in operation in the radiology department in Glasgow Royal Infirmary since 1977; a second unit came into operation in 1980 in the Department of Medical Radiology in Edinburgh Royal Infirmary and a third in Aberdeen Royal Infirmary in 1981.

2.6 While many of the new techniques are now firmly established, new applications are continually being introduced in specific fields of pathology. Essential to the cost-effective use of modern radiological imaging is the ultimate acceptance of planned patterns of investigation.

Teaching Hospitals

2.7 In addition to their teaching obligations, departments in teaching hospitals have a major service load which frequently includes intensive radiological investigations on patients coming from outwith the parent Health Board. The development and evaluation of new imaging techniques takes place in these hospitals, as a consequence, in most cases, of joint research studies with clinical units.

District General Hospitals

2.8 These departments carry a heavy routine service load. Advanced techniques are already carried out in some and are being developed in others. Many departments have incorporated ultrasound and radioisotope scanning: in most cases the latter is a joint effort between medical physicists and radiologists; and this is the ideal arrangement. It is important that adequate manpower and equipment are made available for the new services to be developed.

2.9 In district general hospitals there is no formal establishment for junior radiologists in training. While the policy of limiting initial training in radiology to teaching hospitals is fully supported, consideration might be given to devising formal links between teaching hospitals and district general hospitals for radiologists in the later stages of training. Such an arrangement has a two-way educational role and may *inter alia* encourage consultant recruitment to departments in the district general hospital.

'Cottage' Hospitals

2.10 Radiology departments in 'cottage' hospitals are used by general practitioners and visiting consultants; and they are usually sustained by a radiographer working single-handed. Unless a radiologist is available to make regular visits, the scope of radiographic work should be limited to plain radiography, since contrast radiological examinations are unsatisfactory without the presence of a qualified radiologist to supervise the investigation.

2.11 Some single-roomed departments are equipped with only one examination table, which doubles for fluoroscopy. In these circumstances a 'barium' service by the visiting radiologist is of sub-optimal quality; the screening session is liable to interruption; and the non-radiographic staff are insufficiently experienced to provide proper support. Unless the provision of screening facilities is merited by geographic circumstances, contrast examinations of the alimentary tract should be referred to the larger hospitals.

2.12 Linkage of all single-handed departments with a main centre is essential to allow films to be sent regularly to the main department for reporting; and periodic visits by radiologists to peripheral units are essential to maintain contact both with the radiographer and with the local practitioners.

Neuroradiology

2.13 Neuroradiology is a specialty established in the four main teaching centres in Scotland. The pattern of neuroradiology has changed dramatically with the introduction of CT scanning, as this is now the primary investigation in intracranial disease; all existing CT machines and staff are fully committed and the demands on them may well increase. On the other hand, there has been a decided fall in the use of conventional techniques and the virtual cessation of air studies. Arteriography is still in demand because of the greater interest in the pathophysiology of cerebro-vascular disease and the development of vascular anastomotic surgery. The reduction in conventional angiography is being balanced out by a greater time involvement in interventional techniques. Myelography using the new water-soluble contrast media is in increasing demand.

2.14 All these developments necessitate a level of staffing which will allow adequate time for the teaching of junior staff in neuroradiology.

2.15 The neuroradiologist of the future will have a whole-time commitment to his particular field. Details of the training requirements for consultant neuroradiologists are provided in Chapter 11.

Paediatric Radiology

2.16 Paediatric radiology has developed to a point where it demands full commitment by specially trained consultants in three departments of paediatric radiology in children's hospitals. In the other teaching hospitals, and in district general hospitals, the paediatric element of radiology is integrated with the general radiology commitment.

2.17 The investigative scheme in children requires special expertise in their handling and subjection to modern imaging techniques. Since practical procedures take relatively longer than similar examinations in adults, it is only to be expected that the workload figures per radiologist and radiographer will not reach those achieved for a general department.

2.18 The availability of purpose-designed apparatus is particularly important to facilitate the work of radiologists and radiographers and to provide optimum results with low levels of radiation. The time of trained staff can be saved by the employment of specially trained 'aides' to help with the management of young patients.

2.19 Only the paediatric radiology departments in Glasgow and Edinburgh offer a self-contained ultrasound service for abdominal work (and, in Glasgow, for echo-encephalography). In children, echocardiography is carried out only in the departments of radiology in Aberdeen and the Western Infirmary, Glasgow; in other centres this examination is undertaken by cardiologists.

2.20 At present, children have to be taken to associated hospital units for CT and radioisotope scanning procedures.

2.21 With the progressive incorporation of new imaging techniques into paediatric radiology, staffing establishments must be geared to ensure the provision of adequate training in these techniques and the continuance of high standards of medical practice. Details of the higher training required in paediatric radiology for the general radiologist and for the prospective consultant paediatric radiologist are described in Chapter 11.

2.22 In paediatric radiology departments, a high ratio of senior to basic grade radiographers is required, particularly to prepare these radiographers to maintain high standards of paediatric radiology when they move to posts outside the children's hospitals.

3 Ultrasonic Scanning

3.1 Integration of diagnostic ultrasound with the other new imaging modalities and conventional radiology is essential both on clinical grounds, because of their interdependence, and also to ensure cost-effective use. Where possible the opportunity should be taken to employ an imaging method which uses non-ionising energy or minimal amounts of ionising radiation, particularly during the investigation of children and female patients in the child-bearing age.

3.2 The introduction of ultrasound into clinical medicine was pioneered by Professor Ian Donald of the Department of Obstetrics in the University of Glasgow. Its application in obstetrics provided a method of clearly demonstrating the growing foetus without the risks of ionising radiation.

3.3 Diagnostic ultrasound has subsequently become an increasingly effective tool of ever-widening application. Several excellent reports on diagnostic ultrasound are now available including those of Ferucci (1979), Meire (1979) and the Report of the NMCC Subcommittee for Radiology (1978).

3.4 In terms of capital cost, the basic equipment is the least expensive of the newer forms of imaging apparatus, while the cost per examination is modest.

Obstetrics and Gynaecology

3.5 This discipline is still the main user of ultrasound. The techniques are used for the estimation of foetal growth, the detection of abnormalities and the management of bleeding in early pregnancy. Small real-time scanners are now being provided for the use of obstetricians in ante-natal clinics. Ultrasound can distinguish between solid and cystic lesions in the pelvis, differentiate benign from malignant masses and demonstrate the full extent of the latter. Pelvic inflammation can also be identified and monitored.

Abdomen

3.6 Ultrasound is of considerable value in the detection and delineation of palpable or suspected abdominal masses, and in detecting the presence and location of abscesses. Focal disease of the liver is comparatively easy to detect; cysts and abscesses can be demonstrated and their progress monitored by ultrasound, which can also be used to guide the aspiration needle. In expert hands, success rates of 90% have been reported in the detection of metastases over 1 cm. in diameter. Ultrasound is particularly useful when oral cholecystography fails; and it is now the primary investigation for distinguishing between obstructive and hepatocellular jaundice. Acute pancreatitis can be recognised, and pseudocysts identified and monitored: pancreatic carcinoma and chronic pancreatitis can also be demonstrated.

3.7 A new development in ultrasound is the computed analysis of tissue characteristics.

Urinary Tract

3.8 This includes the evaluation of renal masses, the separation of cystic from solid lesions, tumour extensions and the accumulation of perinephric fluid. Bladder carcinoma can be identified, staged and monitored. The method is useful when the kidney is not demonstrated on pyelography; the transplanted kidney is well suited to ultrasound examination.

Echocardiography

3.9 The last 10 years have seen a rapid advance in cardiac ultrasound techniques, with all cardio-thoracic units now having both single and two dimensional equipment available for the non-invasive assessment of heart disease. These techniques are of paramount importance in the diagnosis of pericardial effusion and have replaced all standard radiological techniques for this diagnosis. They can assess all four heart valves and chambers as well as the inter-atrial and inter-ventricular septa. They are used as an adjunct to, and as a replacement for, cardiac catheterisation both in adults and in children.

3.10 In the diagnosis of neonatal heart disease echocardiography is of paramount importance in assessing congenital heart lesions. It will continue to be a vital non-invasive assessment for many years to come.

3.11 Echocardiography is carried out in departments of radiology in the

Western Infirmary and Southern General Hospital in Glasgow and in Aberdeen. In other centres this examination is undertaken by the cardiologists. However, radiologists in other teaching and non-teaching hospitals are being invited to provide an echocardiography service.

Future Developments

3.12 The ever-increasing application of ultrasound, coupled with the excellent image quality now available, justifies the routine provision of the latest equipment at district general hospital level and this is allowed for in the planning guidance on X-ray room requirements. Ultimately this modality will replace some conventional radiological techniques.

Staffing and Organisation

3.13 Obstetric ultrasound is shared between radiologists, radiographers and obstetricians. Radiographers carry out the bulk of this work.

3.14 In district general hospitals there is a mix of general and obstetric ultrasound, the work being shared fairly evenly between radiologists and radiographers.

3.15 At present, general ultrasound examinations are carried out by radiologists in most cases, but radiographers are becoming involved in this field. As the equipment becomes less operator-dependent, relatively more radiographers will be required.

3.16 Additional radiologists are required to supervise the investigations and interpret the findings, as well as to provide training for radiologists and radiographers. Trainee radiologists are obliged to gain the necessary theoretical and practical experience in ultrasound along the lines laid down by the Royal College of Radiologists. A course of training leading to a diploma of the College of Radiographers may commence in Glasgow in the future.

3.17 The ultrasonic scanning session is made more efficient by the provision of supporting staff to assist with the general management of the patient, and to perform simple technical tasks; this role can be played by nursing auxiliaries or technical assistants ('aides').

3.18 Adequate secretarial assistance is required to make proper booking arrangements and facilitate prompt issue of radiologists' reports.

3.19 Medical physicists have an important role in the further development of ultrasound; and full co-operation between radiologists and physicists is essential to ensure that technical progress is maintained.

4 Radioisotope Scanning

4.1 It is important that radioisotope scanning should be integrated with the other new imaging modalities and with conventional radiology. The use of radioisotopes offers the particular advantage of reducing the dose of ionising radiation to the patient, particularly during the investigation of children and of women in the child-bearing age.

4.2 Radioisotope scanning has a particular role in oncology, but it also has wide application in the investigation and monitoring of benign diseases affecting most body systems.

Bone

4.3 Radioisotope scanning should be the primary technique for the demonstration of metastatic bone disease. The procedure is also finding wider application in orthopaedics, in conditions such as osteomyelitis and benign tumours and in the assessment of bone healing.

Renal Tracts

4.4 Assessment of renal function with modern gamma cameras is being used increasingly. The employment of radio-nuclide cystography to determine vesico-ureteric reflux is a useful technique, which, in comparison with conventional radiological methods, has the added advantage of a limited radiation dose.

Brain

4.5 Radioisotope scanning is almost as accurate as CT as a screening procedure for intracranial pathology; the method is being extended to include dynamic studies of blood flow in the carotid and cerebral arteries.

Cardiovascular System

4.6 Radioisotope methods are useful to assess cardiac wall movement, ejection fraction and cardiac output, and they may well obviate the need for cardiac catheterisation in some patients. Assessment of arterial occlusion is proving useful as well as methods of platelet labelling in the assessment of venous thrombosis.

Lung

4.7 Lung perfusion and ventilation studies are widely used in the diagnosis of pulmonary emboli and no major change is likely in the work pattern of this investigation.

Liver and Biliary Tract

4.8 The use of ultrasound has largely supplanted radioisotope scanning in the demonstration of mass lesions, and in distinguishing between obstructive and hepatocellular causes of jaundice.

Thyroid and Adrenal Glands

4.9 Iodine uptake studies and thyroid scanning are expected to continue on the present scale. There may be some increase in demand for adrenal scanning as new radiopharmaceuticals are introduced.

Staffing and organisation

4.10 Guidelines on the provision of nuclear medicine services are provided in a Report by the Inter-Collegiate Standing Committee on Nuclear Medicine (1981).

4.11 The choice of the appropriate radio-nuclide investigation is a clinical decision which only the trained radiologist (or nuclear medicine consultant) is fully competent to make. The radiologist (or nuclear medicine consultant) should thus be the person responsible both for the management of the patient and for the medical interpretation of the tests. The proper development of radioisotope scanning lies within an integrated imaging service, with the radiologist as the medical person who works closely with the physicist in this field.

4.12 Medical physicists have played a leading role in the development of radioisotope scanning in Scotland. The role of the physicist in major teaching centres is principally that of research and development. In other hospitals, his work is now of a more technical nature, including the preparation of computer programmes. Specialist nuclear medicine physicians are required in only a small number of major teaching centres. Their main concern is with the development and evaluation of new techniques, to be passed into general use once their efficiency is proven. There are three consultants in nuclear medicine in Scotland, namely, one each at the Western General Hospital, Edinburgh, Glasgow Royal Infirmary and Aberdeen Royal Infirmary.

4.13 Radiologists provide a major contribution to this work in the teaching centres at the Western Infirmary and Stobhill General Hospital, Glasgow, the Royal Infirmary Edinburgh, the Dundee Hospitals and in the district general hospitals at Monklands, Falkirk, Stirling and Inverness. (The current commitment in isotope scanning on the part of radiologists and radiographers is detailed in Chapters 9 and 10).

4.14 In the teaching hospitals scanning equipment is sited either in departments of nuclear medicine or in departments of medical physics, where the scans are performed by radiographers or medical physics technicians; in other hospitals, the equipment is generally located in the diagnostic radiology department and operated by radiographers.

4.15 The various techniques are now well established; and automated data processing systems, which can be operated by radiographers after a brief period of training, are available from numerous manufacturers. The cost of the average radioisotope scan is about £16 per examination (at 1980 prices) which is comparable with an ultrasound study.

4.16 It is not economical to install a unit which will perform less than 50 examinations a week. Great care must be observed in the selection and installation of nuclear medicine apparatus in district general hospitals. When such a service is required, adequate staff resources must be provided. (A mobile service for small district general hospitals is presently under evaluation).

4.17 There is a need to establish regular training programmes along the lines recommended by the Royal College of Radiologists and the College of Radiographers. Some training for radiologists is already provided in the teaching hospitals, but, at present, there are no centres in Scotland offering courses leading to the Diploma in Nuclear Medicine of the College of Radiographers.

5 Computed Tomography

5.1 *CT head scanning* is a basic requirement in a central neurological department as a primary investigation. Its availability may extend into district general hospitals in the future. The introduction of this technique has altered dramatically the older pattern of investigation and consequently the 'work mix' of the neuroradiologist. There has been a virtual disappearance of encephalography. While the gross number of arteriograms has fallen considerably, this has been off-set by the requirement for more detailed vascular studies and techniques of interventional type.

5.2 *Whole body scanning* is a natural development of head scanning. In certain instances it is complementary to ultrasound: in others, particularly lung, pleura, mediastinum and spine, it has considerable application, whereas ultrasound has none. Clearly CT scanning must be integrated with other imaging modalities.

5.3 Because of their high capital and running costs the number of CT scanner installations has been strictly limited. The proven clinical value of CT scanning should ensure its provision in large district general hospitals.

5.4 This chapter of our report is the result of experience of whole body CT scanning at Glasgow Royal Infirmary (J G Duncan, 1980). The importance of this technique in relation to oncology is detailed by Husband and Hobday (1981).

Specific areas

5.5 There are certain areas where CT scanning has proved its value:

Thorax

5.5.1 CT scanning can be useful in the assessment of mediastinal invasion in bronchial carcinoma as a guide to operability. Small peripheral lung metastases, frequently missed with conventional radiology, can be identified, and the nature of undiagnosed pleural disease can frequently be clarified.

Liver and Spleen

5.5.2 CT can demonstrate primary hepatic malignancy and certain forms of metastatic disease can be clearly defined. All areas of the liver can be shown more readily than by other scanning methods. One particularly useful aspect is the monitoring of progress after chemotherapy for hepatic malignancy.

Adrenals

5.5.3 The normal and abnormal adrenal can be visualised extremely well and small adrenal tumours less than 1 cm. in size can be identified.

Pancreas

5.5.4 Pancreatic trauma and acute and chronic pancreatitis with and without pseudocyst formation are well identified. CT guided needle biopsy of the pancreas can be performed.

Urinary Tract

5.5.5 CT is a useful complementary procedure in renal disease, particularly in renal cysts and in the assessment of tumour spread to glands and into the retroperitoneal space. The anterior and posterior surfaces of the kidney are particularly well seen. The staging of bladder carcinoma can be assessed with great accuracy.

Gynaecology

5.5.6 The clear definition of tissue planes in the pelvis gives an accurate assessment of the spread of pelvic malignancy, and the staging of cervical and ovarian malignancy, with monitoring of progress, is thereby enhanced.

Lymphoma and Hodgkin's Disease

5.5.7 The location of glandular enlargement is well demonstrated, treatment can be monitored and any recurrence of the disease detected.

Parathyroid Glands

5.5.8 The location of parathyroid adenomas has proved to be a useful application of CT, particularly in the long-standing difficult case.

Future Developments

5.6 Except in large neurological departments with a regional or national commitment, there would seem to be little value in having a dedicated head scanner installation. Most of the technological developments have taken place on the whole body scanner and all orders being placed in the USA are now for units capable of performing general purpose work.

5.7 The purchase of whole body CT scanners will be based primarily on an administrative decision but a case could be made out for the main centres having priority in general purpose scanner allocation. Whether these would be second generation (medium speed) or third generation (fast speed) scanners would depend largely on the resources available. Should it be considered that a group of district general hospitals outside the main centres justified a scanner, installation of a second generation unit would cover all the likely requirements.

Staffing and Organisation

5.8 The equivalent of one whole-time consultant radiologist is required for the efficient working of a scanner unit. Routine supervision and checking of scans can be carried out by junior staff under the supervision of the consultant. Until the place of CT scanning is more clearly defined, more follow-up and research work is necessary, and for this purpose it would be of considerable benefit if a registrar, senior registrar or medical assistant could be employed, on a research basis, in each department housing a general purpose CT scanner.

5.9 Two whole-time radiographers and one part-time radiographer are necessary for the efficient running of a unit. This complement should consist of one superintendent Grade III radiographer, one senior radiographer and one basic grade radiographer—who may rotate through the scanning unit from the main X-ray Department.

5.10 Secretarial help is necessary for the typing and issuing of CT reports, the filing of permanent records and the arranging of appointments in conjunction with the radiographic staff. Copies of all patients' CT records, as well as magnetic tapes under the appropriate disease index, should be available in the CT unit. A permanent record of the CT report should be filed in the main X-ray files.

5.11 One full-time nurse is essential for the running of a scanner unit. This nurse must be thoroughly conversant with the scanning routine so that the procedure can be explained fully to patients and the necessary preparation arranged at the appropriate time. Radiologists in training gain experience in head CT in the four main teaching centres, and of whole body CT in Glasgow, Edinburgh and Aberdeen. Radiographers gain experience in this field during in-service training.

6 Interventional Radiology

6.1 The term 'interventional radiology' includes a wide range of procedures of a diagnostic and therapeutic nature, many of which have developed from the angiographic expertise developed in the 1950s. They include transluminal angioplasty, therapeutic procedures such as embolisation of vessels in malignant tumours, percutaneous biopsy of bone, lung and retroperitoneal organs and diagnostic and therapeutic procedures in relation to the biliary tract (Dotter, 1981). Many of these procedures will obviate the need for in-patient treatment or major operation, with a resultant saving in resources.

Arterial Occlusive Therapy

6.2 Therapeutic embolisation means the deliberate occlusion of blood vessels by emboli introduced through an angiographic catheter in a clinical situation where it is appropriate to obliterate the local blood flow. Materials used range from autologous blood clot to extraneous material such as Gelfoam. More permanent results can be achieved by stainless steel coils.

6.3 The control of gastro-intestinal bleeding in the poor risk patient is probably the most frequent indication. The left gastric and gastro-duodenal arteries can be obliterated once endoscopy has established the site of bleeding and other methods have failed. Gastro-oesophageal varices can be occluded by transhepatic catheterisation of the portal vein.

6.4 Abnormal vascular communications, malformations, etc—angiodysplasias—can be successfully embolised in many parts of the vascular system, including the brain and spinal cord.

6.5 Therapeutic embolisation of renal carcinoma has been used to arrest severe blood loss and reduce the size of the tumour pre-operatively and in the inoperable case. In oncology, selective and superselective catheterisation of vessels may be required to deliver cytotoxic drugs to specific areas.

Transluminal Angioplasty

6.6 There are now many reports of considerable clinical and haemodynamic improvement following dilatation of iliac, femoral and popliteal stenosis, by means of a greatly improved dilating catheter which incorporates an inflatable polyvinyl balloon. Dilatation of renal artery stenosis causing severe hypertension, or as a post-operative complication of renal transplantation, is now being practised.

Percutaneous Biopsy

6.7 Percutaneous biopsy of bone lesions in the lumbar or dorsal vertebrae, the ilium, ribs and other sites can be carried out under local anaesthesia and fluoroscopic control; this obviates the need for 'open biopsy', under general anaesthesia, in a surgical operating theatre. Transthoracic biopsy of intrapulmonary lesions may obviate the need for thoracotomy in some cases. Transabdominal biopsies of the kidney, retroperitoneal lymph nodes and abdominal masses have been facilitated by the technical improvements in ultrasound, using 'real time' probes.

Biliary Tract

6.8 The diagnostic procedure of percutaneous transhepatic cholangiography has been supplemented by the use of transhepatic catheters to provide biliary drainage, and to dilate anastamotic ductal narrowings. Retained biliary calculi can be removed percutaneously under fluoroscopic control.

6.9 Interventional radiology should be encouraged both in teaching and in district general hospitals. Radiologists experienced in catheter techniques are well placed to innovate and develop these useful techniques. The time-consuming nature of the procedures, however, creates the need for additional radiologists.

7 New Developments: Nuclear Magnetic Resonance: Digital Radiography

Nuclear Magnetic Resonance

7.1 Nuclear Magnetic Resonance (NMR) Tomographic Imaging is a non-invasive, non-ionising method of demonstrating cross-sectional anatomy and pathology of the whole body (Edelstein *et al.* 1981).

7.2 The technique is based on measuring the responses of the hydrogen protons of tissue placed within a magnetic field to an applied radio frequency radiation. The display pattern is based on a proton density or proton spin-lattice relaxation time (T_1). The proton density and the T_1 images represent the distribution of water and fat within different organs. By measuring the T_1 it is possible to differentiate between normal tissue and malignant change or inflammation. NMR has been shown to be more accurate than either isotope liver scan or ultrasound in the demonstration of hepatic tumours and in differentiating benign from malignant tumours (Smith *et al.* 1981). Similarly, it has been shown to be very accurate in the diagnosis of pancreatic lesions both benign and malignant and in differentiating benign from malignant involvement of the prostate and breast.

7.3 Vascular structures in the mediastinum are clearly distinguishable from solid organs and tumour masses. There may be future applications in cardiology in terms of ventricular function and cardiac output studies.

7.4 NMR appears to be of similar sensitivity to CT in the demonstration of intracranial tumours, and has shown a remarkable capacity to demonstrate affected areas of nervous tissue in patients with multiple sclerosis (Doyle *et al.* 1981). The method has not yet been compared with body CT.

7.5 NMR is an important new imaging technique which is in due course likely to replace some existing procedures. The capital and running costs should be less than those of CT; in consequence installation of NMR may take precedence in smaller hospitals.

Digital Radiography

7.6 The development of sophisticated television enhancement systems, using digital electronics, and improved electronic recordings of images have made possible the technique known as digital radiography. Instead of recording the image on conventional X-ray film, it is converted into an electronic image which can be stored and handled by computer in the same way as computerised tomography images (Mistretta *et al.* 1981).

7.7 At the present time the most widely accepted application of this technique is in the production of angiograms obtained by the intravenous injection of contrast medium. Although there are some limitations on resolution, the images of contrast in the arteries which are obtained are adequate for many diagnostic purposes (Mistretta, Crummy and Strother 1981).

7.8 Digital radiography is likely to be preferred in clinical situations where a direct arterial puncture carries undue risk or where repeated studies are deemed necessary. Some change in the design of angiographic apparatus is an inevitable consequence.

7.9 It seems likely that this technique will find applications in other fields, as the quality of the stored images improves, and as developments in the storage of the images (eg the video disc) are fully exploited. A significant consequence of these technological advances might be the eventual demise of the X-ray film as the conventional recording medium.

8 Economic Use of Imaging Services

8.1 The continuous development of radiological procedures and the increasing expectations of the public, together with an incomplete understanding by clinicians of the value and limitations of imaging techniques, have led to a progressive increase in the use of the radiological services of about 5% per annum over the last decade. In 1980 there was a slight reduction in this continuous progression, the cause of which is not clear. The radiologist, as custodian of the radiological services, has often taken insufficient responsibility for regulating the supply of these services and for educating his clinical colleagues in their use. This has led to excessive use of techniques which are outmoded or whose limitations are greater than their value.

8.2 Certain investigations, which are of little clinical value, are being studied by the Royal College of Radiologists with the object of advising ultimately that these should be discontinued. An example of such an investigation is the pre-operative chest radiograph in young symptomless patients. It is felt that a more critical approach should be taken both by clinicians and by radiologists towards routine requests and towards those investigations which are unlikely to influence patient management.

8.3 The newer, more definitive, tests should, as far as possible, supersede the less satisfactory ones, eg radioisotope bone scanning should replace skeletal survey for metastatic disease. This policy could accelerate both management decisions and therapeutic endeavours. Reshaping of the demands on diagnostic radiology departments is essential in order to minimise the expansion of the establishment of medical and technical staff.

8.4 The fundamental weakness, which underlies the unsatisfactory use of diagnostic imaging services, is the retarded development of the subject at an academic level in this country. Efforts are being made to improve undergraduate education on the place of those diagnostic services so as to promote more effective application of radiology to patient care. To this end, the continuing development of clinical/radiological conferences at hospital and ward level is essential.

8.5 Scrutiny of all radiological requests is impracticable but it should be applied to cases which involve a number of investigations or personal participation by the radiologist. Limiting requests for special or emergency investigations to the authority of the consultant or senior registrar might be considered. Within the radiology department itself management methods should be introduced, such as reviewing the incidence of technically unsatisfactory radiographs in order to reduce waste, and the regular assessment and maintenance of equipment.

8.6 It should be possible to devise some method of financial incentive to promote more efficient departmental organisation. A proportion of any proven savings might be returned to the imaging department to be set aside for teaching aids, the conduct of small projects and so forth. Opinion is divided on the merits of departmental budget systems proper.

8.7 The total revenue cost, in 1980, of the radiological services in a large general hospital, including all costs and charges other than the capital cost of the building, was £650,000 for a through-put of 50,000 patients per annum—a figure which represents 5% of the total running costs of the hospital. With expenditure of this magnitude it is obvious that great care must be exercised in the use of these diagnostic services.

8.8 Approximate costs (at 1980 prices) of common investigations have been calculated as follows: Chest—£12; Lumbar Spine—£18; IV Urogram—£26; Barium Meal—£20; Barium Enema—£28; Ultrasound Examination (non-obstetric)—£20–£30; Translumbar Aortogram—£170; Renal Arteriogram including selective study—£185; Basic Radioisotope Scan—£16.

9 Workload of Radiologists: Commitment to New Techniques

9.1 The term 'examination' is imprecise since it gives no indication of the nature of the procedure nor of the time required for its completion. For this reason a workload system based on the average time involvement of the radiologist in each of the many different procedures was devised for use in Scotland.

9.2 Since the time taken up by the same technique may be very different for radiologist and radiographer, the radiologist workload scheme described in Appendix B had to be distinct from the Foresterhill Unit System for measuring radiographer workload referred to in Chapter 10.

9.3 Using this radiologist workload scheme, which is based on a points system, the total radiologist points worked in individual departments during the survey months, together with the number of radiologist sessions required, were submitted to the Information Services Division of the Common Services Agency. The returns for March, 1980 and 1981 were completed with the exception of those of two of the smaller health boards; three departments in Glasgow and Edinburgh gave no returns for 1981, so their data for 1980 was used. The survey embraced 100 consultants, 28 senior registrars and 26 second and third year registrars.

9.4 In March, 1980, the total number of radiologist sessions was 5,027, comprising 3,763 whole-time equivalent consultant sessions and 1,264 'corrected' senior registrar and registrar sessions. The total points return was 1.0 million, giving an average of 200 radiologist points per session. In March, 1981 the corresponding figures were 5,329 (4,168 and 1,161); the total points figure rose to 1.2 million with an average of 225 radiologist points per session (Table Ia). The greater number of sessions in 1981 reflects the increase in consultant radiologist establishment which had occurred; this was accompanied by an increase in the overall workload, the points per session being roughly the same.

9.5 In March, 1980 the sessional pointage was over 210 in most hospitals with major teaching commitments; in non-teaching hospitals the sessional pointage was 210 in over half and less than 180 in the remainder. These figures suggest that the current workload is excessive, particularly in many of the hospitals with teaching commitments. The significance of these figures is explained in Appendix B.

Commitment to New Techniques

9.6 To ascertain the involvement of radiologists in the new imaging techniques, the points contributed by radiologists to each modality were recorded in March, 1980 and March, 1981, using the system described earlier. Information on the sessional involvement of radiologists was kindly made available by individual departments as this is not obtainable from the unit system as it stands. Details of this work are given in Tables IIa, IIb, III and IV.

Ultrasound

9.7 This modality is now firmly established in all teaching hospitals in the main centres and in most district general hospitals.

9.8 Radiologist ultrasound is almost entirely 'non-obstetric' in the teaching hospitals at Aberdeen Royal Infirmary, the Department of Surgical Neurology, Edinburgh, the Western General Hospital, Edinburgh, Glasgow Royal Infirmary, the Institute of Neurological Sciences, Glasgow, the Southern General Hospital, Stobhill Hospital and the Western Infirmary, Glasgow. Radiologists are involved in obstetric ultrasound at Glasgow Royal Maternity Hospital and the Simpson Memorial Maternity Hospital, Edinburgh. In district general hospitals, the ultrasound work is either mainly general or obstetric. Details of this work are given in Tables IIa and IIb.

9.9 The ultrasound points total for March, 1980 was approximately 70,000 in teaching hospitals and 25,000 in other hospitals, rising to 77,000 and 34,000 respectively in 1981; the rise was due mainly to an increased workload in many of the established units, other departments having submitted figures for the first time.

9.10 Some 500 radiologist ultrasound sessions were recorded in March, 1981 which represents 12-13 whole-time equivalent consultants. There are now probably some 30 or more consultant radiologists engaged in this work.

Radioisotope Scanning

9.11 Nuclear medicine physicians are engaged in radioisotope scanning in Aberdeen Royal Infirmary, the Western General Hospital, Edinburgh and Glasgow Royal Infirmary. There is consultant radiologist commitment at the Western Infirmary, Glasgow, the Institute of Neurological Sciences, Glasgow, the Southern General Hospital, Stobhill Hospital, Edinburgh Royal Infirmary, Ninewells and also the district general hospitals in Falkirk, Stirling, Monklands, Inverness and Kirkcaldy. Details of the work are shown in Table III.

9.12 Between 1980 and 1981, the NM consultant points rose from 21,000 to 27,000 and the radiologist points from 20,000 to 25,000; the latter figure was due mainly to a 50% rise in workload at Western Infirmary, Glasgow and returns coming from Southern General Hospital and Stobhill Hospital for the first time.

9.13 The total units represent the work of approximately 10 consultants on a sessional basis. This is the equivalent of 3 or 4 whole-time consultant posts.

Computed Tomography

9.14 CT head scanning is established in radiology departments in the Department of Surgical Neurology, Edinburgh, the Institute of Neurological Sciences, Glasgow, Aberdeen Royal Infirmary and Ninewells. With the exception of Ninewells the 6 or 7 consultant radiologists involved are engaged almost exclusively in neuroradiology.

9.15 Between March 1980 and 1981, the total radiologist figures remained constant at 40,000 points (190 consultant radiologist sessions).

9.16 CT whole body scanning is currently available in Glasgow Royal Infirmary and Edinburgh Royal Infirmary; in the former the radiologist points total rose from 8,000 to 11,000 between March, 1980 and March, 1981 (over 80 consultant radiologist sessions). Details of all CT work are given in Table IV.

Summary

9.17 The workload points for the three new imaging techniques for march, 1981 were: ultrasound—110,000; radioisotope scanning—25,000; CT scanning (head and body)—57,000. The total of 192,000 points represents almost 20% of the total radiologist points while the 1,058 sessions required equates to a similar percentage of the grand total of radiologist sessions.

9.18 The workload points for radiologists rose from 1.0 million to 1.2 million, while the number of points per session rose from 210 to 229.

9.19 The radiologist commitment to new imaging techniques is now substantial. The current system, whereby consultants carry the main workload, should continue so that a high quality of service is maintained.

9.20 It is important that monitoring of radiologist workload continues, since some increase in consultant radiologist establishment will be inevitable in the absence of any significant fall in the total amount of conventional radiology.

10 Workload of Radiographers: Commitment to New Techniques

Workload

10.1 Since 1975 the Foresterhill Unit System has been used to measure the work undertaken by radiographers in Scotland. The annual workload is estimated from the returns made by individual departments for the month of March each year to the Information Services of the Common Services Agency. The method has been described by Gillanders and Abbot (1981), and is summarised in Appendix C.

10.2 The national figures for March, 1977, 1980 and 1981 are shown in Table Ib. They show that the workload has levelled off at about 3.1 million units (during normal working hours) per month.

10.3 These figures do not indicate the change which is occurring in the *type* of work performed; the extent of radiographer involvement in the new imaging techniques is described in the following sections.

Commitment to New Techniques

10.4 The relative involvement of radiologists and radiographers in new imaging techniques varies from department to department and from one modality to another. The data in Tables II, III and IV relate to radiographer involvement in new imaging techniques based on the workload units performed in the survey months of March, 1980 and 1981. Information on the sessional involvement of radiographers (and radiologists) was kindly made available by individual departments, this not being obtainable from the Unit System as it stands.

Ultrasound (All Types)

10.5 In March, 1980, a total of 89,000 units of ultrasound work was performed by radiographers, comprising 52,000 units and 37,000 units in teaching hospitals and non-teaching hospitals respectively: in 1981 the figures rose to 138,000 (82,000 and 56,000). The workload increased in the established departments while returns were received, for the first time, from Edinburgh Royal Infirmary, Bangour, Dumfries, Hairmyres and Stracathro.

Obstetric Ultrasound

10.6 The practice of obstetric ultrasound is shared between radiologists, radiographers and obstetricians. In March, 1981, radiographers performed 95,000 units (250 sessions) compared with 25,000 units (104 sessions by radiologists).

General Ultrasound

10.7 Initially all general ultrasound procedures were carried out by radiologists, but radiographers are becoming progressively more involved. Practice varies between different centres; in some cases the radiographer may assist in the examination without operating the probe, whilst in others the radiographer carries out the scan, the radiologist being concerned only with checking and reporting.

10.8 The overall recorded sessional involvement of radiographers with all forms of ultrasound was over 400 in March, 1981. However, it can be seen from Table II that information on the radiographer sessional time is incomplete; also there are some discrepancies between the points return and sessional time allocated which precludes detailed assessment and comparison.

10.9 It is thought that between 10 and 15 whole-time equivalent radiographers are involved in this modality, the actual number engaged probably being twice as many.

Radioisotope Scanning

10.10 One radiographer is employed whole-time in the radiology departments in Edinburgh Royal Infirmary, Monklands and Stirling, but only on a limited sessional basis in Falkirk and Kirkcaldy. Radiographers are seconded to departments of nuclear medicine at the Western General Hospital, Edinburgh, Glasgow Royal Infirmary and Stobhill Hospital.

10.11 The scanning procedures are carried out by technicians in the department of nuclear medicine at Aberdeen Royal Infirmary and in the other hospitals in Glasgow. The radiographer unit total in March, 1980 was

66,700 units, rising to 94,000 in March, 1981. Details of this work are provided in Table III.

10.12 It is estimated that some 7 or 8 whole-time equivalent radiographers are involved in carrying out these procedures at present. Comparing the large points total with the recorded sessions suggests that the time allowances for radiographers in radioisotope scanning procedures are excessive. (See Appendix C).

Computed Tomography

10.13 Radiographers are engaged in CT head scanning in radiology departments in the Department of Surgical Neurology, Edinburgh, the Institute of Neurological Sciences, Glasgow, Aberdeen Royal Infirmary and Ninewells.

10.14 Radiographer work amounted to some 71,000 units in March 1980 and 83,000 units in March, 1981. Details are given in Table IV.

10.15 There are discrepancies between the number of radiographer sessions and the points totals; this is probably because the 20 or so radiographers involved frequently carry out other neuroradiological techniques and plain radiography. The extent to which radiographers rotate into CT scanning units from main departments has not been studied.

10.17 In Glasgow Royal Infirmary, radiographer units for whole body scanning rose from 8,000 to 11,000 (110 sessions) in the twelve month period.

10.16 The composite return for head and body scanning received from Edinburgh Royal Infirmary for March, 1981 gives a total of 9,480 units (126 sessions).

Summary

10.18 Radiographers are involved in all three new imaging techniques; this involvement increased between March, 1980 and March, 1981, particularly in the case of ultrasound, where radiographers now carry out the bulk of the procedures.

10.19 The figures indicate an increase in the degree of participation by radiographers in general ultrasound work. The extent to which radiographers operate the apparatus in general ultrasound has not been determined.

10.20 Radioisotope scanning is undertaken in radiology departments and departments of nuclear medicine, the scanning procedures being carried out by radiographers and nuclear medicine technicians. The workload continues to rise; the current time allowances for radioisotope scanning procedures in the Foresterhill Unit System seem excessive and are being revised (Appendix C).

10.21 Radiographer participation in CT is also rising within the existing units; and this involvement will extend to the introduction of additional whole body scanning units.

10.22 It is estimated that at least 40 whole-time equivalent radiographers (or 70 to 80 actual radiographers) are now committed to new forms of imaging. The absence of a rise in the gross Foresterhill Unit figures between 1977 and 1981 suggests that a proportion of conventional radiography is being replaced by ultrasound.

11 Consultant Radiologist Demand: Radiologists in Training: Teaching of Radiology

Consultant Establishment

11.1 The radiologist establishment at 30 September 1980 was as follows: consultants 113, medical assistants 1, honorary consultants 3, senior registrars 30, registrars 47 and SHOs 1.

11.2 During the past 5 years 11 consultant posts had to be filled annually. This was due partly to an increase in establishment and partly to a number of early retirements. It is exceptional for a consultant post in Scotland to be vacant for an extended period.

11.3 Table Ia suggests that the 'procedural' element referred to in Appendix B dominates radiologist work; revision of the time allowances for radiologist procedures may reduce this apparent imbalance. Nonetheless, it is fairly certain that an excessive workload in respect of some departments will still exist.

11.4 Already some 20% of procedural time is given over to new imaging techniques. Consultant participation dominates, and this is important to ensure that high standards are maintained in this rapidly developing field.

11.5 There must clearly be an expansion of the consultant grade. This expansion must not be achieved by reducing the number of radiologists in basic training; it is important to maintain both a balanced 'grade mix' and sufficient numbers in training for the future consultant establishments.

Radiologists in Training

11.6 In contra-distinction to general medicine and surgery, the proportion of registrars to senior registrars in radiology in the United Kingdom is about 1.5 to 1. This is reasonable on the basis that few of those embarking on a radiological career drop out during training. A Scottish establishment of not less than 44 is therefore recommended. There are increasing demands for the redistribution of junior manpower by specialty; the case for this is more powerful when funds to provide additional training posts in radiology are lacking.

11.7 There is little difficulty in filling basic grade training posts by a mix of United Kingdom and overseas graduates. However, as the proportion of overseas graduates joining the NHS progressively declines, more UK graduates must be recruited into the specialty.

Academic Departments

11.8 Progress towards the creation of full academic units in the main teaching hospitals is proceeding slowly. Edinburgh has the only university funded academic department of radiology. There is a clinical professor and university funded senior lecturer in Aberdeen. Dundee has one university funded senior lecturer. The academics are heavily committed to undergraduate and postgraduate education, as well as playing some part in service duties. Difficulties exist at present in obtaining honorary senior registrar status for university lecturers and also in providing the necessary secretarial and technical help from university sources.

11.9 The intermediate Diploma in medical Radiodiagnosis provides a useful criterion for senior registrar appointments (as well as still being a suitable qualification for a staff post in some overseas countries). The anticipated discontinuation of the Conjoint Board DMRD will leave only the Diploma of Medical Radiodiagnosis of the Universities of Aberdeen and Edinburgh available in Scotland.

Undergraduate Teaching

11.10 Undergraduate teaching should be restricted to an understanding of the value, limitations, risks and costs of modern imaging techniques and their place in clinical management strategy. It should not include the acquisition of interpretative skills. In the pre-clinical years, static and dynamic imaging methods can be employed by radiologists to illustrate living anatomy and physiology. In the clinical years, formal lectures should be limited to those which are systems orientated and integrated on clinical lines with attendance by students at joint X-ray conferences between radiologists and individual ward units. Periods of attachment of students singly to the radiology department are popular with students and provide them with a practical appreciation of the wide range of imaging methods now employed.

11.11 The Royal College of Radiologists (1981) has produced an excellent document on the subject of undergraduate education in radiology.

Postgraduate Teaching

11.12 This takes the form of teaching to radiologists in training and to clinicians taking higher examinations. In the present staffing situation, most of this teaching has to be undertaken by NHS radiologists in competition with their service duties. More senior staff are required urgently in order to provide sufficient 'in depth' training, particularly in the new imaging modalities. Considerable practical involvement by radiologists in training is essential for the necessary skills to be acquired; and this needs a high level of supervision by the teacher.

11.13 For radiologists intending to commit themselves to a career in neuroradiology, a minimum period of one year's intensive training (and preferably two) after taking the FRCR is recommended by the British Society of Neuroradiologists.

11.14 For those aiming for consultant posts in paediatric radiology, a period of at least 6 months full-time equivalent training, after taking the FRCR, is advisable.

12 Schools of Radiography: Radiographer Supply and Demand

12.1 Radiographic training schools are established in association with the teaching hospitals in Glasgow, Edinburgh, Dundee and Aberdeen. The College of Radiographers advises on the staffing levels of the schools. The clinical teaching departments of radiology provide the facilities for the practical training of student radiographers. Good working relationships between the teaching staff of the school and the senior radiographic staff within these departments are of the utmost importance. Where possible, some schools provide facilities for post-graduate training of radiographers and instruction in radiographic techniques, photography and film processing for radiologists in training.

12.2 Until 1980, the average output from the Scottish Radiographic Training Schools was between 75 and 80. A reduced output of between 50 and 60 is expected until 1982/83 on account of a fall in recruitment and a high 'drop-out' rate during training (Table V). Furthermore, the introduction in 1982 of the extended three-year training course will cause a reduction in output in the year 1984.

12.3 The high drop-out rate during training in the late 1970s appears to be less of a problem following an elevation of the required educational qualifications for school entry; however, this factor has yet to be tested against the extended syllabus. In recent years the schools have been handicapped by an intermittent shortage of suitable applicants and by late withdrawals shortly before the commencement of courses.

12.4 Demand for radiographer staff in the 1980s is difficult to forecast. The annual output in the 1970s, referred to above, seems to have been absorbed into the NHS without difficulty, but requirements in the 1980s may well depend on the financial resources available. Monitoring of demand is clearly essential in the interests both of the training schools and of the employing authorities. At present, there are no training centres in Scotland offering courses leading to the diploma in ultrasound or nuclear medicine, but it is anticipated, as indicated in para. 3.16, that a training course leading to the diploma in medical ultrasound may be instituted in Glasgow in the future.

13 Radiology Departments: Design and Organisation: Staffing: Use of Computers

Design and Organisation

13.1 The design of radiology departments in new hospitals has often been less than satisfactory. This should be rectified by the revised Hospital Building Note No 6, due to be published in the near future. The Building Note also recognises the fundamental importance of the central physical location of the department in relation to the main users, ie ward units, out-patient clinics and accident and emergency departments.

13.2 The integration of imaging services, including radiology, ultrasound radioisotope, CT and other imaging techniques, in a single department (or complex) with a common records system should be encouraged by appropriate building design. The importance of a separate integrated imaging record store within the diagnostic department must be stressed.

13.3 The high capital and revenue costs of a radiology imaging department make it essential that it is efficient in its operation. Objective measurements of progress should be established to monitor improved performance. The management structure of the department must be clearly defined by the consultant in administrative charge; relationships with relevant line managers outside the radiology department need to be clarified. There is an urgent need for management training for radiological, senior radiographic and clerical staff, particularly in organisation and method.

Staffing

13.4 The staff of the radiology department represent an amalgam of skills, ranging from those of the radiologist to those of radiographers, nurses, clerical staff, dark-room technicians and porters. The service to the patient requires the harmonious and co-operative effort of all sections of staff.

13.5 Given the complex staff requirements of a teaching hospital radiology department, the administrative and organisational tasks are not insignificant.

These responsibilities are normally shared by the radiologist, who is in overall administrative charge, and the superintendent radiographer; the administrative responsibilities of the latter frequently include those of the purchasing officer for consumables and those of the District Finance Officer for the maintenance of appropriate financial records.

13.6 Staffing establishments must not be derived purely from the 'raw' workload statistics obtained from the Foresterhill Unit system, but must be determined as a result of detailed discussions of local requirements between radiologists, radiographers and employing authorities.

13.7 The value of the nursing staff in the radiology department has long been established. These nurses are usually under the general control of the nursing administration, but they integrate well as members of the radiology department and make important contributions in terms of general patient care and by assisting in special procedures.

13.8 The introduction of daylight systems has reduced the number of darkroom technicians required and has altered their role to some extent; some have become involved in other departmental activities such as the sorting of films and their preparation for reporting. As in the case of all other members of staff, it is important that these members find interest in their work.

13.9 The smooth functioning of the clerical section of the department is essential for the efficient running of the department as a whole. A wide variety of vital tasks is undertaken by the clerical staff, including the filing of patients' records, reports and films, the arranging of appointments, the reception of patients, and the provision both of statistical information and of a secretarial service. In addition it is necessary for the clerical staff to have administrative and operational links with senior radiological and radiographic staff. It is important that the clerical staff are under the control of an office supervisor of a grade appropriate to this responsibility. There is a need for intermediate grades who can take responsibility for certain functions within the office structure. In general, the current gradings are inadequate in terms of the important work undertaken.

13.10 An arrangement whereby the portering staff are employed exclusively in the X-ray department is to be preferred, since it fosters team relationships and makes porters rightly feel an important section of the departmental staff.

Use of Computers

13.11 Although there is a widespread use of computers in the United States, and to a growing extent in England in the clerical and to a lesser extent in the clinical areas of Radiology Departments, so far only three departments in Scotland are using these machines, viz the Southern General Hospital, Stobhill Hospital and Monklands Hospital. Modern developments in computer hardware have reduced the capital costs considerably, whilst extending their potential. At moderate cost in relation to the capital invested in radiology departments, computers can provide word processing and documentation preparation. They can also produce management statistics and carry out many other functions which assist in the day-to-day performance of the department. With the development of standard software packages it is anticipated, that in the near future, it will be possible to buy off-the-shelf systems suitable for any type of department. (Sutherland and Shimmins 1980).

14 Note of Main Conclusions and Recommendations

The Changing Work Pattern

14.1 The introduction of the newer imaging techniques of ultrasound, radioisotope scanning and computed tomography has initiated a progressive change in the work pattern of many departments of diagnostic radiology. In many instances conventional radiographic techniques are being displaced, or else being supplemented, by the diagnostic information obtained from simpler procedures.

14.2 Ultrasound, radioisotope scanning and interventional radiology will soon become part of the normal facilities available in all teaching and district general hospitals; the future provision of whole body CT scanning is undetermined as yet. The newest techniques of nuclear magnetic resonance and digital radiography are likely to have important clinical applications.

Contribution of Newer Techniques to Patient Management

14.3 As well as being highly efficient diagnostic methods of showing the internal structure of many organs, the new imaging techniques have the advantage that they are largely non-invasive.

14.4 Some savings in bed occupancy can be achieved, since many of the new techniques are painless and can be performed on an out-patient basis.

14.5 While of proven value in monitoring the progress of pregnancy, ultrasound now has wide application in the abdomen, the eye, the heart and many other organs.

14.6 Radioisotope scanning, like ultrasound, is a relatively inexpensive imaging method. It is of established value in the diagnosis of intracranial disease, bone disease and pulmonary infarction, as well as in the assessment of renal function.

14.7 CT scanning is now standard equipment in a main neurological unit. Whole body CT has an important role in complementing, or substituting for, ultrasonic scanning. On occasion it may be the only imaging method capable of making a precise diagnosis; it is thus important that sufficient general purpose scanners are available in Scotland.

Effect of New Techniques on Workload and Staffing

14.8 The incorporation of these new techniques, without the provision of additional staff, has been responsible, in some instances, for the excessive workloads which are known to exist in certain departments.

14.9 It is estimated that some 20 whole-time equivalent radiologists and 40 whole-time equivalent radiographers are presently involved in the new forms of imaging.

14.10 Advice on resource allocation should reflect trends both in workload and in staffing. This requires regular monitoring of overall workloads and, in particular, of the extent to which the new imaging techniques are replacing conventional radiology.

14.11 Separate data concerning radiologist and radiographer commitment are required, since their respective involvement in individual procedures varies between departments and is subject to change. For example, ultrasound is presently heavily operator-dependent and more radiologists are required to operate the apparatus: as technical advances occur, this trend may change to a need for relatively more radiographers.

14.12 More staff are required to manage the service but also to provide the necessary practical training in new forms of imaging; this highlights the importance of maintaining adequate recruitment into both professions.

14.13 The provision of essential nursing staff to help with the general management of the patient will allow radiologists and radiographers to devote more time to the examination of the patient.

Deployment of Resources

14.14 The cost of providing radiological services represents a significant proportion of hospital expenditure. In the interests of efficiency, careful management of the operation of the radiology imaging service is essential.

14.15 Radiologists must be prepared both to assume responsibility for the organisation, in the widest sense, of the patient's radiological imaging and to develop closer links with clinical colleagues to encourage more effective use of the imaging department.

14.16 The importance of the radiology department in patient management must be recognised by locating it in a central position in new hospitals and by concentrating imaging equipment to facilitate an integrated approach to the investigation of the patient.

14.17 A policy for the regular replacement of modern imaging equipment is essential.

14.18 Adequate resources are required to establish, or further develop, the new imaging techniques in district general hospitals. Scanning equipment for general ultrasound should be an integral part of the radiology service and should be planned so as to incorporate obstetric ultrasound where necessary.

14.19 The radioisotope scanning service should be organised jointly with medical physics departments; for the time being this modality is likely to be preferred to general purpose CT scanning on grounds of cost.

14.20 The effective performance of an imaging service depends to a considerable extent on its clerical staff who must be adequately graded and of high calibre. Modern computer systems have an important part to play in the documentation and administration of the department, and can be used to assist budgetary control. The return of any financial savings to the imaging department would be an added incentive to greater efficiency.

14.21 Links between teaching and district general hospitals are advantageous in many ways. Senior registrars can have greater responsibility working in the latter, the staff of which benefit from contact with the recently trained.

14.22 In the light of these important developments in radiological imaging, the physical extension of radiological services into the community will have to be carefully controlled. Referral of patients to a large hospital department is to be preferred in most cases.

MEMBERSHIP OF RADIOLOGY SUB-COMMITTEE OF THE NATIONAL MEDICAL CONSULTATIVE COMMITTEE

Chairman

Dr J G Duncan (resigned May 1982)	Radiologist in Administrative Charge, Royal Infirmary, Glasgow
Dr S J Arnott (appointed May 1982)	Senior Lecturer in Radiotherapy, Western General Hospital, Edinburgh

Members

Dr L Cram	Registrar in Radiology, Western Infirmary, Glasgow
Dr G E Flatman	Director, Glasgow Institute of Radiotherapeutics and Oncology, Western Infirmary, Glasgow
Professor L A Gillanders (resigned May 1981)	Clinical Professor in Radiology, Aberdeen
Dr M Hadley (appointed May 1982)	Consultant Radiologist, Royal Infirmary, Inverness
Dr F Kelly	Consultant in Radiotherapy and Oncology, Belvidere Hospital, Glasgow
Dr A E Kirkpatrick	Consultant Radiologist, Royal Infirmary of Edinburgh
Dr S McCall-Smith	Consulting Radiologist, Peel Hospital, Galashiels
Dr J A K Meikle	Consultant Radiologist, Perth Royal Infirmary
Dr J S Scott	Consultant Radiotherapist, Ninewells Hospital, Dundee
Dr K Wood	Consultant Radiologist, Bangour General Hospital, Broxburn

METHODS OF ASSESSMENT OF WORKLOAD—RADIOLOGISTS

Duties of a Diagnostic Radiologist

The duties of a diagnostic radiologist are given over to a wide range of activities, viz: (a) Clinical radiology of a PROCEDURAL nature, ie, the performance of specialised techniques (eg barium work), the checking and reporting of radiographs; (b) NON-PROCEDURAL clinical radiology such as X-ray conferences and clinical consultations and administration; (c) TEACHING of undergraduate and postgraduate students.

Procedural Work

The parameters recognised in the United Kingdom as indicative of radiologist workload for purposes of assessing establishments are based on the *procedural* work of radiologists. They are 'number of patient day attendances' or 'number of examinations'.

Non-Procedural Radiology (or 'Non-Service Load')

The Faculty Points System introduced in 1972 (DHSS DS 89/72), embraced both teaching and non-procedural clinical radiology. A non-service load of 40% was given to teaching hospitals, 30% to large hospitals with 6 or more diagnostic rooms and 10% to all others.

Teaching

The DHSS DS 89/72 letter gave a 10% reduction in workload to teaching hospitals.

On the other hand, the Wright Report on Medical Staffing in the Hospital Service in Scotland (1964) made no distinction between teaching and non-teaching hospitals in its recommendation of a figure of 15,000 'patient day attendances' per consultant radiologist per annum.

Establishments

Further factors have to be taken into account when deciding the consultant establishment appropriate to a particular department, eg the main type of patient examined, which can diminish the work-rate (eg paediatric), and the level of provision of supporting staff. A 'population served' method (Table VI) is suspect, allowing neither for teaching nor for the existence of supra-area services.

Radiologist Points System in Scotland

Originally in this system, radiologist procedures were divided into three classes, A, B and C, with time-allowances of 3, 21 and 72 minutes respectively (as in the original Faculty Points System). In November, 1981 the number of classes of radiologist procedures was increased to five, with time allowances as follows: Class A—3 minutes; Class B—10 minutes; Class C—20 minutes; Class D—40 minutes; Class E—60 minutes. In individual departments, the recording of radiologist procedures is generally performed by the radiographer, or by the radiologist or an assistant where there is no radiographer involvement. The Foresterhill Daily Sheet was suitably expanded to allow separate recording of radiographer and radiologist work, and to show the number of procedures performed in classes A to E the total points in each class and the grand total of points for all procedures for the department.

The national return form completed for a department shows the staff establishment and the precise number of radiologists carrying out the work during the survey month; this is expressed as sessions carried out by consultants (whole-time equivalents) and junior staff; the correction factors used to convert the work contribution of junior staff to consultant equivalents are:—senior registrars 0·75; second and third year registrars 0·5.

The national data collated by the Information Services Division of the CSA has been made available for discussion within the profession.

On the basis that a notional hospital session takes 3½ hours, the radiologist points (minutes) taken would be 210. This sessional period embraces all forms of radiologist activity set out in the opening paragraphs of this Appendix.

METHOD OF ASSESSMENT OF WORKLOAD—RADIOGRAPHER

Since 1975, the Foresterhill Unit System has been used to measure the work undertaken by radiographers in Scotland (Gillanders and Abbot, 1981). The annual workload is estimated from the returns made by individual departments for the month of March each year, to the Information Services Division of the Common Services Agency.

The Foresterhill Unit System is a time-based method in which the whole range of radiographic examinations is divided into 5 categories according to the average time taken for the procedure; each category has been allocated a number of units (minutes) ranging from 7 to 90. The radiographer records the basic information as her work proceeds by entering a 'tick' or an appropriate code number on the standard form. The number of units for a particular room or department can then be calculated.

Returns submitted from individual departments set out the work performed during normal hours, shift-work, 'on-call' radiography and travelling time. The establishment is shown, as well as the numbers of whole-time and part-time radiographers in post. The Scottish data is correlated by the Information Services Division and issued to all Health Boards for the information of staff. It should be noted that the 'raw' unit figures do not make allowances for patients who are physically or mentally unable to co-operate in the radiographic examinations, (eg paediatric or geriatric patients); 'loadings' for these are more suitably applied in respect of 'type of hospital served', rather than in respect of individual patients. For this reason, Boards are advised that the 'raw' data must not be interpreted in isolation and that full discussion must be held between local radiographers and radiologists before any administrative action based purely on this data is taken.

Establishments

Before deciding on an appropriate establishment, account has to be taken of matters such as 'type of hospital served', level of supporting staff, 'on-call' requirements and travelling.

Time Allowances—New Imaging Techniques—Date Recording

Few amendments have proved necessary in respect of the time allowances for conventional radiographic and radiological techniques in the Foresterhill Unit System.

This is not the case, however, in respect of the new imaging techniques, within which a large number of individual procedures has rapidly evolved. In 1980 a joint working group from the Radiology Subcommittee of the NMCC and the Radiography Subcommittee of the NPCC revised some of the existing time allowances and allocated new time allowances and code numbers for radiographers and radiologists in respect of the many techniques which are in operation at present.

In order to assess the national use of new imaging techniques, the Foresterhill Forms to be used from March 1982 onwards have been modified to allow the collection of such data separately from that relating to conventional radiology.

Attention is drawn to the fact that more detailed data, suitable for local use, can be obtained by entering the appropriate code number of each procedure instead of a 'tick', in the appropriate column of the FUS 'daily sheet'.

APPENDIX D

COSTS OF MODERN RADIOLOGICAL IMAGING APPARATUS

(at 1981 Prices)

Conventional Radiological Apparatus

Generator	£15,000
X-ray Tube	£3,500
Tube Column: Floor to Ceiling Type	£4,500
Tube Column: Ceiling Suspended Type	£9,000
Bucky Table	£4,500
Mobile X-ray Unit	£12,000
Screening Table	£35,000
Image Intensifier and Closed Circuit TV	£32,000
Vidicon Tube	£2,000
AOT Film Changer	£12,000
Automatic Film Processor	£4,000

Approximate Costs of Certain Installations

General Radiographic Room (Health Centre, fixed installations)	£25,000
Dedicated Screening (Barium) Room	£75,000–£150,000
Angio-cardiographic Room—Single plane	£300,000
Bi-plane	£470,000

Ultrasound Equipment

Standard Scanners (Incorporating static ‘B’ scanners, real-time scanner and cardiac system	£32,000–£57,000
Dedicated Cardiac Units	£22,000–£38,000
Linear Array Systems	£13,000–£25,000
Phased Array Systems	£33,000–£37,000
Rocking Crystals System Sector Scan: Approx.	£35,000

Equipment for Radioisotope Scanning

Gamma Camera	£50,000
Data Processing Units	£30,000–£50,000

Computed Tomography Equipment

Dedicated Head Scanning Unit	£150,000
Whole Body Scanning Unit	£340,000–£425,000

Annual Spend on the Replacement of Radiological Equipment in Scotland

(Excluding Computed Tomography Scanners and Equipment Provided by Centrally Supported Schemes).

1977/78	£4.2 million
1978/79	£2.1 million
1979/80	£1.5 million

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TABLE 1a

RADIOLOGIST WORKLOAD: NORMAL HOURS

Survey Month	Total Radiologist Points in Millions	Consultant Sessions	Total Sessions (Including Junior Staff)	Points per Session
March 1980	1.0	3,763	5,027	200
March 1981	1.2	4,168	5,329	225

TABLE 1b

RADIOGRAPHER WORKLOAD: NORMAL HOURS

Survey Month	Total Unit Workload in Millions	Whole-time Equivalent Radiographers in Post	Workload per Radiographer
March 1977	3.18	704	4,492
March 1980	3.11	756	4,118
March 1981	3.075	743	4,125

TABLE IIa

COMMITMENT TO NEW TECHNIQUES—ULTRASOUND

Teaching Hospitals	Radiologist Points (and sessions in brackets) 1980	Radiologist Points (and sessions in brackets) 1981	Radiographer Units (and sessions in brackets) 1980	Radiographer Units (and sessions in brackets) 1981
Aberdeen Royal Infirmary	10,000 (28)	15,162 (40)	Nil	Nil
Dundee	3,400 (?)	2,360 (24)	Nil	Nil
Edinburgh Royal Infirmary	NR (?)	10,140 (38)	NR	14,100 (27)
Edinburgh Hospital for Sick Children	1,200 (9)	3,400 (16)	Nil	Nil
Gartnavel	3,950 (?)	2,772 (21)	Nil	Nil
Glasgow Royal Infirmary	8,000 (36)	4,830 (24)	NR	4,600 (18)
Glasgow Royal Maternity	2,300 (12) M	2,620 (13) M	12,920 (20)	11,440 M (20)
Glasgow Western Infirmary	8,360 (56)	11,820 (55)	4,580 (7)	7,120 (33)
Simpson Maternity Edinburgh	2,520 (?) M	2,620 (?) M	9,700 M (?)	11,440 M (20)
Southern General Glasgow	6,400 (40)	4,030 (17)	12,000 (16) M	16,720 (32) M
Stobhill Glasgow	3,840 (40)	6,630 (44)	1,200 M (6)	1,420 (8)
Victoria Glasgow	2,400 (11)	6,300 (20)	Nil	Nil
Western General Edinburgh	13,520 (28)	11,067 (40)	10,120 (?) ⅓M	13,960 (40) ⅓M
Yorkhill Glasgow	2,140 (?)	2,982 (?)	1,980 (?)	2,520 (?)

NR = No Return M = Maternity (but not exclusively)

Ultrasound rating 1980/81				
Obstetric	Radiologist	One Class B	= 20 points	Some obstetric ultrasound may be included in those returns where no 'M' is shown.
	Radiographer	One Class II	= 20 units	
Non-Obstetric	Radiologist (Operator)	Two Class B	= 40 points	
	Radiologist (Report only)	One Class B	= 20 points	
	Radiographer	One Class III	= 40 units	

TABLE IIb

Other Hospitals	Radiologist Points (and sessions in brackets) 1980	Radiologist Points (and sessions in brackets) 1981	Radiographer Units (and sessions in brackets) 1980	Radiographer Units (and sessions in brackets) 1981
Ayr Central	3,000 (16) M	3,000 (17) M	2,500 M (16)	3,860 M (17)
Bangour	NR	(11)	NR	2,360 (11)
Bellshill Maternity	5,740 (14) M	10,740 (40) M	7,940 M (5)	11,520 M (21)
Dumfries	NR	252 (4)	NR	200 (?)
Falkirk	6,070 (?) M	3,640 (14) M	3,980 M (?)	8,160 M (33)
Hairmyres	NR	1,071 (11)	NR	1,020 (11)
Kirkcaldy Victoria	1,320 (?)	1,386 (4)	Nil	Nil
Kirkcaldy Firth Park	Nil	Nil	2,600 M (20)	4,120 M (27)
Law	2,560 (20) M	3,060 (20) M	2,560 (15) M	3,160 (20) M
Monklands	4,480 (20)	5,560 (28)	4,480 M (20)	4,600 M (22)
Peel	NR	1,400 (5)	NR	1,400 (11)
Perth	2,400 (?)	Nil	Nil	Nil
Rutherglen Maternity	Nil	Nil	8,000 M (31)	2,600 (12) M
Stirling	1,600 (?)	3,020 (?)	4,800 M (20)	4,780 M (33)
Stracathro	NR	882 (4)	NR	760 (7)

NR = No Return M = Maternity (but not exclusively)

Ultrasound rating 1980/81			
Obstetric—Radiologist	One Class B	= 20 points	Some obstetric ultrasound may be included in those returns where no 'M' is shown.
Obstetric—Radiographer	One Class II	= 20 units	
Non-Obstetric—Radiologist (Operator)	Two Class B	= 40 points	
Non-Obstetric—Radiologist (Report only)	One Class B	= 20 points	
Non-Obstetric—Radiographer	One Class III	= 40 units	

TABLE III

COMMITMENT TO NEW TECHNIQUES—RADIOISOTOPE SCANNING

	Radiologist Points (and sessions in brackets)		Radiographer Units (and sessions in brackets)	
Teaching Hospitals	1980	1981	1980	1981
Aberdeen Royal Infirmary	6,600 (NMC)	9,520 (NMC)	37,000 (NMT)	51,570 (NMT)
Dundee	500 (5)	980 (?)	—	—
Edinburgh Royal Infirmary	NR	3,260 (11)	NR	14,670 (42)
Western General Edinburgh	8,200 (NMC)	12,033 (NMC)	37,000 (?)	51,570 (80)
Glasgow Institute Neurol. Sciences	NR	2,500 (3)	NMT	NMT
Glasgow Royal Infirmary	6,000 (NMC)	4,800 (NMC)	29,700 (?)	42,840 (22)
Western Infirmary Glasgow	7,700 (16)	11,172 (20)	36,000 (NMT)	47,880 (NMT)
Southern General Glasgow	NR	280 (4)	NMT	NMT
Stobhill Glasgow	NR	1,407 (4)	NMT	NMT
Other Hospitals				
Falkirk	600 (?)	—	2,700 (?)	2,430 (13)
Inverness	3,000 (4)	—	NMT	NMT
Monklands	2,600 (?)	3,380	5,200 (?)	15,210 (44)
Kirkcaldy	600 (?)	— (4)	2,700	2,880 (8)
Stirling	1,600	680	7,200 (?)	3,060 (2)

NMC = Nuclear Medicine Consultant
NR = No Return

NMT = Nuclear Medicine Technician
— = Not known

RIS Scan Rating 1980/81 } Radiologist—One Class B = 20 points
Radiographer—One Class V = 90 units

TABLE IV

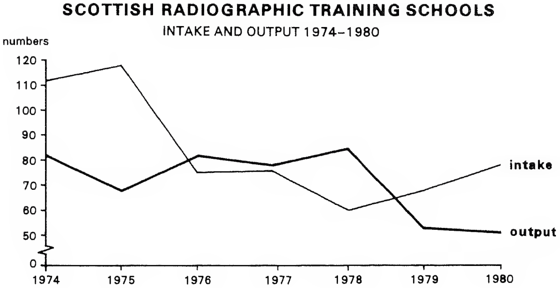
COMMITMENT TO NEW TECHNIQUES—COMPUTED TOMOGRAPHY

	Radiologist Points (and sessions in brackets)		Radiographer Units (and sessions in brackets)	
	1980	1981	1980	1981
Aberdeen Royal Infirmary	7,000 (?)	7,440 (24)	9,840 (?)	11,160 (80)
Dundee	6,000 (?)	4,920 (50)	9,000 (?)	7,380 (44)
Edinburgh D S N	11,000 (?)	10,720 (60)	1,650 (?)	18,960 (40)
Glasgow I N S	16,000 (?)	16,960 (42)	24,000 (?)	25,440 (100)
Edinburgh Royal (Head and Body)	NR	6,320 (42)	NR	9,480 (126)
Glasgow Royal (Body)	8,000 (?)	10,950 (53)	12,000 (?)	11,173 (110)

NR = No Return

CT Scan Rating 1980/81 } Radiologist— One Class B = 40 points
Radiographer—One Class IV = 60 units

TABLE V


SCOTTISH RADIOGRAPHIC TRAINING SCHOOLS
INTAKE AND OUTPUT 1974–1980
numbers
120
110
100
90
80
70
60
50
0
1974
1975
1976
1977
1978
1979
1980
intake
output

CONSULTANT ESTABLISHMENT TO POPULATION BY HEALTH BOARD

RADIODIAGNOSIS

Health Board	Consultant Establishment 1	2	3	Population	Ratio of to Population
Ayrshire and Arran	7		7	375,759	1 = 53,680
Borders	2		2	99,519	1 = 49,760
Argyll and Clyde	6		6	459,282	1 = 76,547
Fife	6	1	7	340,341	1 = 48,620
Greater Glasgow	30		30	1,012,041	1 = 33,735
Highland	4		4	191,188	1 = 47,797
Lanarkshire	12		12	571,737	1 = 47,645
Grampian	9	1	10	471,944	1 = 47,194
Orkney				18,030	
Lothian	23		23	748,603	1 = 32,548
Tayside	11		11	399,191	1 = 36,290
Forth Valley	4	1	5	271,210	1 = 54,242
Western Isles				29,681	
Dumfries and Galloway	3		3	142,465	1 = 47,488
Shetland				22,309	
Scotland	117	3	120	5,153,300	1 = 42,944

1. Numbers in post at 30 September 1980.
2. Vacant posts.
3. Consultant 'Establishment'.

Source: HMSO Census, vacant posts at 30 September 1979.

The populations of Orkney and Shetland are included in Grampian Health Board.

The population of the Western Isles is included in the Highland Health Board.

Printed in the UK by HMSO Press, Edinburgh
Dd 735632/4311 3/83 (205630)